Ewing Mountain Vegetation Project Environmental Assessment

Draft Geology Report

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for:
Mt. Rogers National Recreation Area
George Washington and Jefferson National Forests

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Existing Condition

Geology is the foundation of ecosystems. Geology controls or influences the characteristics and spatial distribution of soils and associated vegetation, surface waters, stream drainages, and groundwater. The project area has two geology-based ecosystems with distinctly different existing conditions:

1. Carbonate geology-based ecosystem dominated by dolomite and limestone
2. Siliciclastic geology-based ecosystem dominated by sandstone and quartzite

Understanding characteristics and spatial distribution of the carbonate and siliciclastic ecosystem Is an integral part of assessing the environmental consequences on soil, water, vegetation, and other components of the ecosystems in the project area (Figure 1).

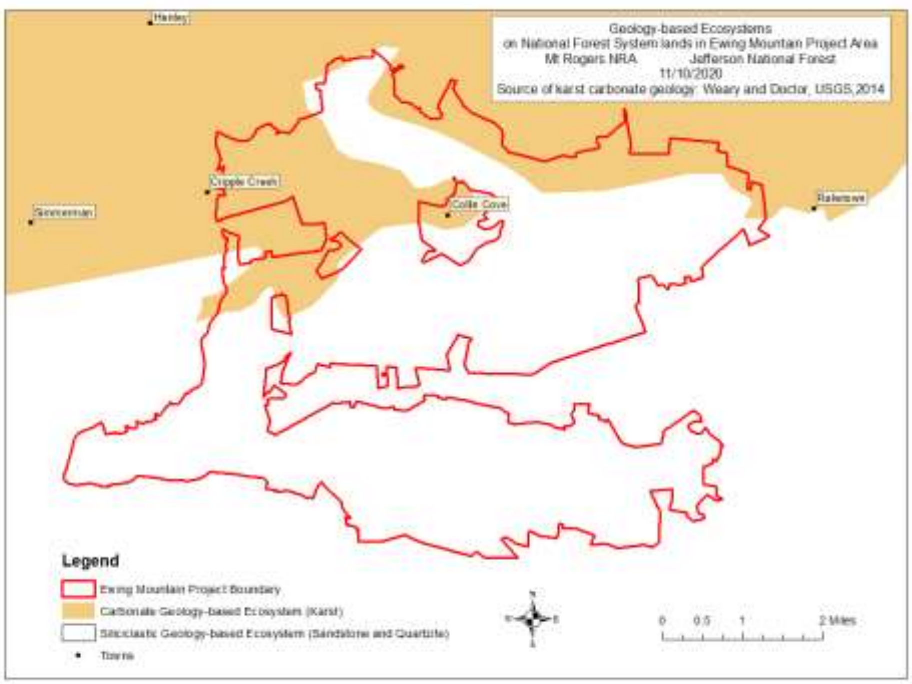

Figure 1. Geology-based Ecosystems in Ewing Mountain Project Area.

Carbonate geology-based ecosystem

Karst-forming dolomite (dolostone) and limestone bedrock occur in the northern part of the project area (Hubbard, 2001; Weary and Doctor, 2014). As a result, there is a carbonate geology-based ecosystem on 3,419 acres (20%) of the project area (Figure 1). Geologic processes operating on carbonate bedrock (Shady Dolomite and the Rome Formations) result in the development of karst. Karst is a type of geological terrain where underground dissolution of the bedrock creates sinkholes, sinking streams, caves, springs, underground streams, aquifers with large flows of groundwater, and other karst features.

Visible karst feature like sinkholes are scattered in the project area, except for a unique cluster of karst features in the Raven Cliff Karst Area Management Rx 4C1. Karst processes are active, on-going processes affecting the surface and subsurface, and are drivers of a dynamic karst ecosystem on 20% of the project area.

The Nature Conservancy has developed a climate change adaptation strategy based on geologic diversity as the foundation for biological diversity and resiliency to climate change (Anderson and Ferree 2010; Anderson, et al. 2013). Assessing effects relating to climate change is another reason to understand the distinctly different geology-based ecosystems in the project area.

Carbonate bedrock (limestone and dolomite) and karst are common in the valleys west of the Blue Ridge in Virginia. Most of the Great Valley of Virginia through which Interstate 81 traverses is karst land, settled and developed into farms, towns and cities. The karst in the project area is on the southeastern edge of the large expanse of karst in Virginia. But one part of the karst in the project area (Raven Cliff karst area) is unique in all the karst in Virginia.

Raven Cliffs karst area (Management Prescription 4C1)

The Raven Cliffs karst area contains an exceptional collection of karst features within a compact area. It offers a rare opportunity to see and learn about many karst features in one location, such as sinkholes, disappearing streams, springs, and karst windows into underground streams.

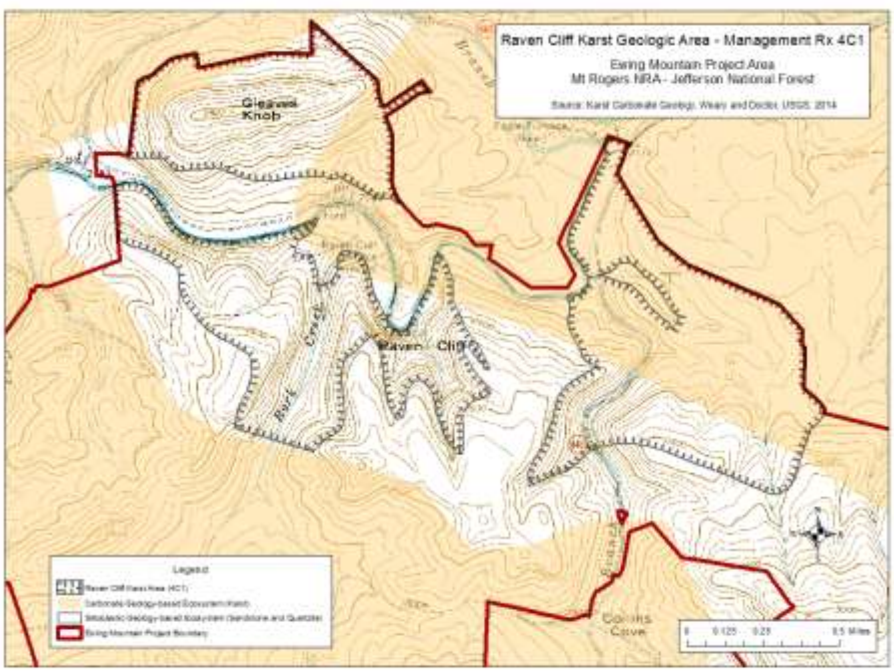

Figure 2. Raven Cliff Karst Geologic Area (Management Prescription 4C1) in the Jefferson Land and Resource Management Plan.

In 1996 during the environmental analysis for a timber sale the Forest Geologist identified the Raven Cliff karst features and their significance. Also identified was the vulnerability of groundwater to contamination in this karst area which includes karst windows with groundwater flows exposed to the surface. The Forest Geologist recommended special protection for this karst area and designation as a Geologic Special Interest Area. This led to a detailed scientific study of the area, including a physical and biological inventory. The study recognized the exceptional collection of karst landforms and resources and recommended the area be considered as Geologic Special Interest Area (Smith and others, 1997). In 2004 the Revised Land and Resource Management Plan for the Jefferson National Forest provided the special designation of Geologic Area for the Raven Cliff karst area. The Raven Cliff Karst Geologic Area is managed under Management Prescription 4C1 in the Plan (Figure 2).

Siliciclastic geology-based ecosystem

Most of the karst is between elevations 2200 feet and 2600 feet. South of the karst area the topography rises steeply into Ewing Mountain, Long Ridge, and Iron Mountains. This steep mountainous terrain between elevations 2600 feet and 3700 feet is due to sandstone and quartzite bedrock, which are more resistant to erosion than the limestone and dolomite in the karst area. Sandstone and quartzite (Erwin and Hampton Formations and Unicoi Formation) form the foundation of the siliciclastic geology-based ecosystems on 13, 823 acres (80%) of the project area.

Table 1. Geology-based ecosystems with distinctly different existing conditions in project area.

	Carbonate Geology-based Ecosystem	Siliciclastic Geology-based Ecosystem
Bedrock	dolomite (dolostone) & limestone	sandstone & quartzite
Dominant minerals	dolomite & calcite	quartz
Chemical composition	$CaMg(CO_3)_2$ & $CaCO_3$	SiO_2
Chemical Compound	calcium magnesium carbonate & calcium carbonate	silicon dioxide (silica)
Acres in project area	3,419	13,823
Percent of project area	20%	80%

It is important to note that the carbonate geology-based ecosystem is based on more than the karst features. Fundamentally, the basis for the carbonate ecosystem is the physical and chemical properties of dolomite and limestone, and the resulting effects on soil and water and other components of the ecosystem. Even if karst were not present, the carbonate terrain would be distinctly different from the siliciclastic terrain. The carbonate terrain is richer and more fertile than the siliciclastic terrain. The acid deposition sensitivity of soil and water in the project area is distinctly different in carbonate geology terrain compared with the siliciclastic geology terrain.

Bedrock is important because it influences the characteristics and distribution of soils and associated vegetation and wildlife habitat, as well as surface waters and groundwater. But bedrock is only one part of geology. The role of geology in developing and sustaining ecosystems is more comprehensive than the type of bedrock. Geology includes:

1) *geologic material components* (solid, liquids, gases) of ecosystems: bedrock; surface materials (such as soils, colluvium, alluvium) ; surface waters; groundwater; and their physical and chemical properties.
2) *geologic processes* that are active drivers of ecological changes in the project area. Geologic processes include stream processes, groundwater movement, weathering, soil development, erosion, sediment delivery to streams, mass movements (landslides), karst processes, etc. Geologic processes that are part of the natural disturbance regime in the project area include flooding, landslides, and ground collapse (sinkhole formation or expansion)
3) *geologic structures* within and between bedrock and overlying surface deposits (such as bedding planes, fractures, and faults in bedrock; the nature of the contact between bedrock and overlying materials such as colluvium).
4) *geologic landforms (geomorphic features)* that develop because of geologic processes operating on geologic materials and structures, and reflect geologic controls or influences on slope aspect, slope gradient, elevation, stream channel types, drainage patterns, sediment load, etc.

Existing condition modified by human activities

The previous discussion focused on natural geologic conditions in the project area. The following discussion will focus on geologic conditions modified or altered by human activities in the project area, such as historic mining activity, roads, timber harvest, grazing allotments, recreation developments, and trails.

Historic Mining Activities and Abandoned Mine Lands

Mining activities in the 19^{th} century and early part of the 20^{th} century included 1) digging surface prospect pits to explore for minerals (iron) , 2) excavating open pit mines or trenches to mine ore, 3) building railroads, 4) washing and processing ore, 4) furnaces to smelt the iron ore, 5) cutting timber and making charcoal to fuel the furnaces. The iron mines were in the carbonate rocks (Shady dolomite). The furnaces were built using sandstone and quartzite.

Mining activities resulted in substantial changes in landforms including 1) cut slopes (prospect pits; open pit mines; highwalls, railroad cut slopes), 2) fill slopes, waste piles, detention dams, and mud wash (ore wash) areas behind the detention dams.

The abandoned mine workings have resulted in slope instability which continues into the present. The Little Wythe mine is just south of Fry Hill. The highwall from the Little Wythe mining in the early 20th century is still unstable and producing new slope failures (Figure 3). The highwall has at least four recent landslides (Witt, A.C., 2020).

Figure 3. Landslide in highwall of Little Wythe mine south of Fry Hill (May 6, 2020).

The iron ore occurs in a clayey matrix in weathered bedrock (Shady dolomite). The excavated mix of ore and clay was moved, often by railroad, to an ore washing site where the clay was washed from the ore. Detention dams were constructed across tributary streams to collect and settle the mud and muddy water washed from the ore.

A stream valley tributary to Francis Mill Creek is shown on USGS 1889 topographical map (Figure 4). By 1930 the tributary valley was filled with sediment behind a detention dam constructed for ore washing operations. The tributary stream is buried under the sediment-filled reservoir and is not shown on the USGS 1930 topographical map (Figure 5).

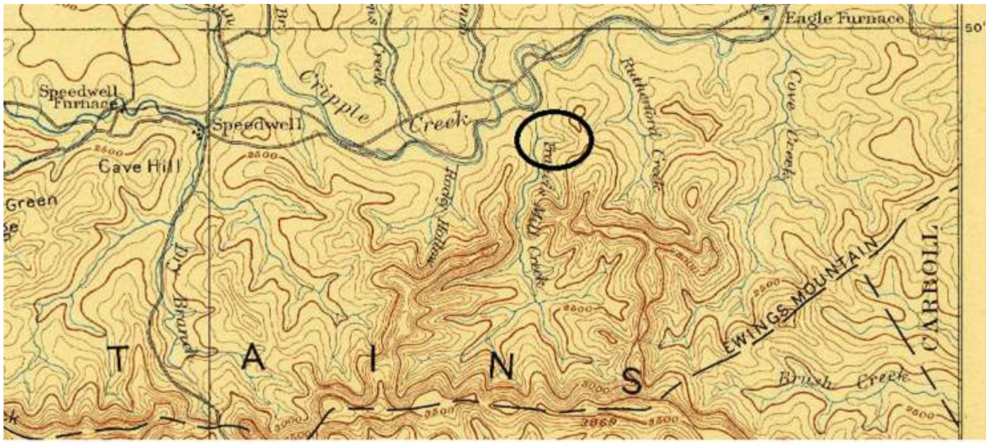

Figure 4. Stream valley tributary to Francis Mill Creek (circled area) on USGS 1889 topographical map (scale 1:125.000)

Figure 5. By 1930 the tributary valley was filled with sediment behind a detention dam constructed for ore washing operations. The tributary stream was buried and not shown on the USGS 1930 topographical map (scale 1:62,500)

The ore wash sediment-filled reservoir behind the detention dam is shown in a LIDAR hillshade image (Figure 6). The tributary stream shown on the 1889 topo map is buried under the sediment reservoir.

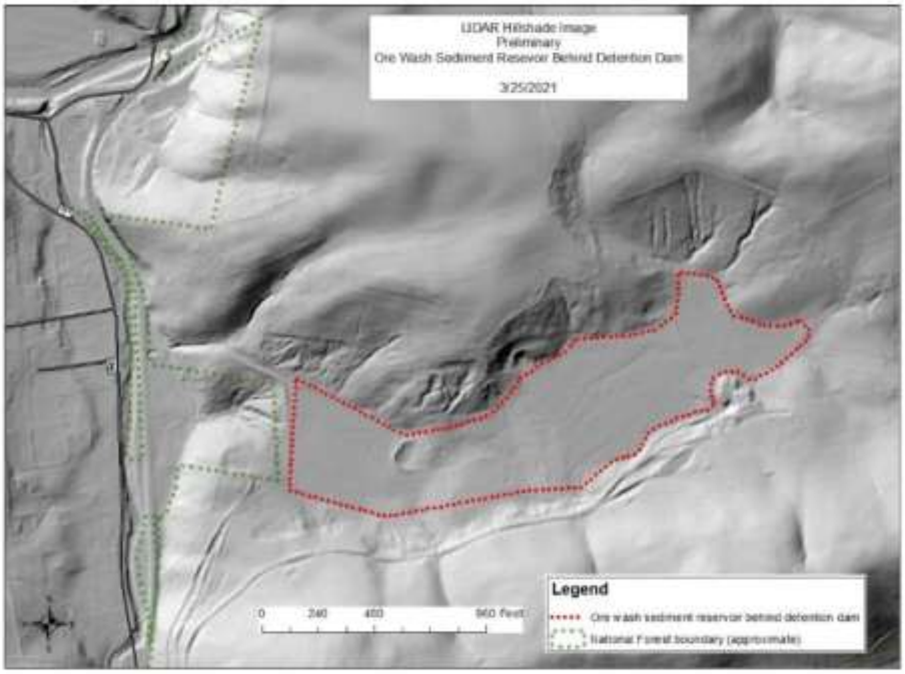

Figure 6. LIDAR hillshade image shows the ore wash sediment-filled reservoir behind the detention dam. Gully incision is visible on the downstream face of the detention dam

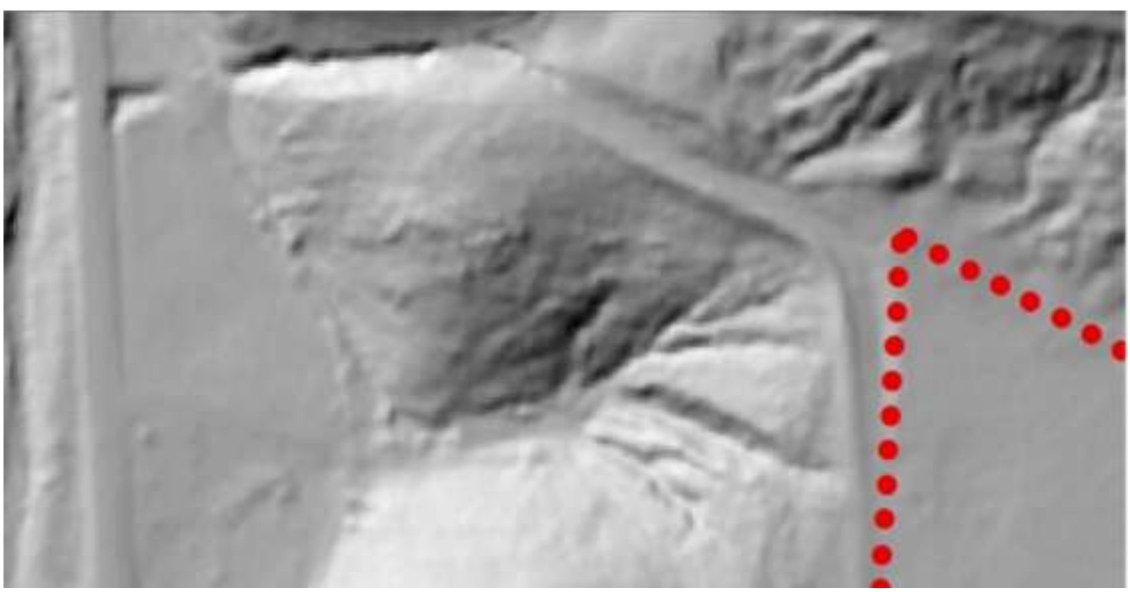

Figure 7. Enlarged detail of LIDAR hillshade image shows: 1) sediment-filled reservoir (outlined by red dots) next to crest of the detention dam, 2) incised gullies on the downstream face of the dam, 3) a spillway, 4) an incised gully where the spillway discharges north of the dam

In 1995 the federal government acquired this land with the sediment-filled reservoir and with part of the detention dam. It appears that some reclamation occurred in the mid-to-late 1980s when it was private land. The reclamation included construction of spillway (northwest-trending) off the north end of the dam (north-trending) (Figure 7). The reclamation also constructed a berm along the crest of the dam as well as along the downhill edge of the spillway.

Gully incision on the face of the dam may have been one reason for the reclamation (Figure 7). Unlike a water reservoir with a level water surface, the sediment-filled reservoir has a sloping ground surface (Figure 8).

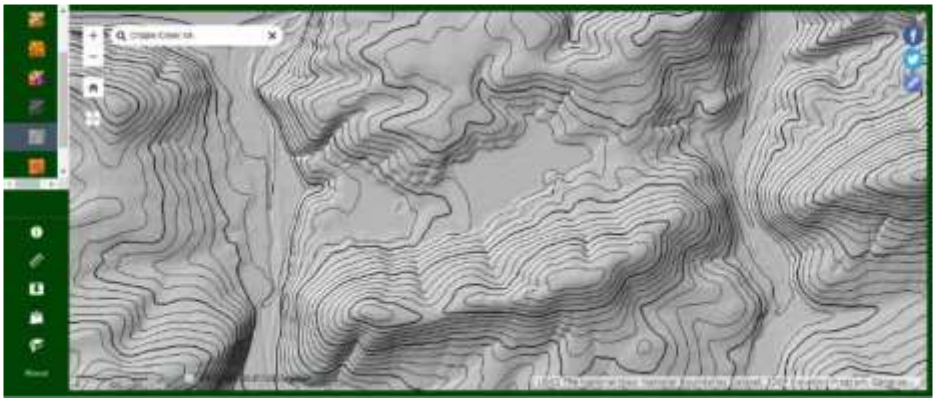

Figure 8. 5 meter contour map showing slope of sediment-filled reservoir draining downslope to the detention dam. Source: Contours generated by U.S. Geological survey 3DEP Elevation Program

The sediment-filled reservoir has been used as grazing pasture for decades. The pasture land is a few hundred feet wide and extends about 2,000 feet upslope from the dam (Figure 9). With only a grass cover, the pasture is subject to surface flow from storm water. During intense rainstorms the storm water flows toward the dam crest.

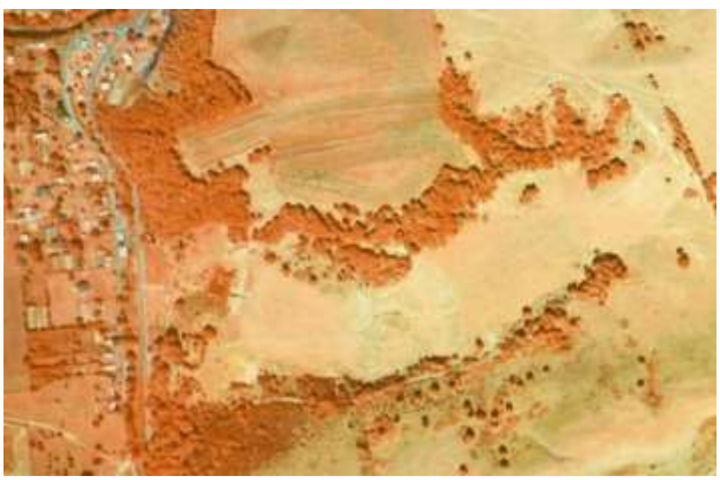

Figure 9. Sediment-filled reservoir used as pasture. 2.000' long pasture drains downslope to the detention dam. (September 1981 USDA aerial photo)

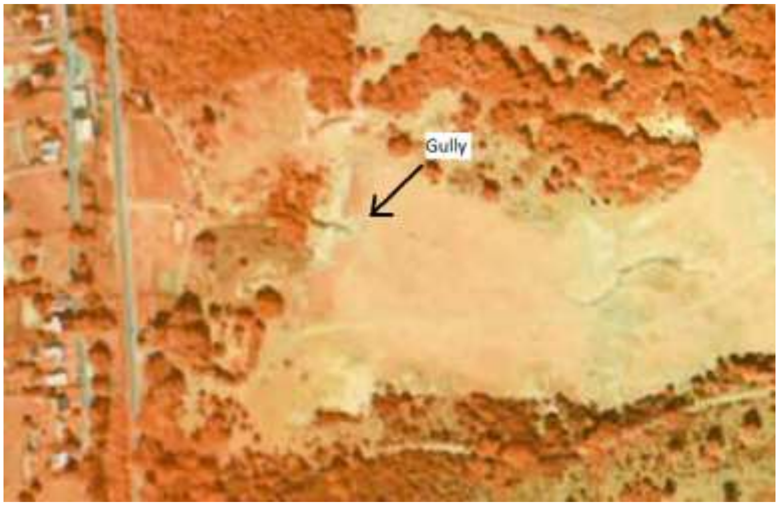

Figure 10. Gully in crest of detention dam.
(September 1981 USDA aerial photo)

The gully incised into the crest of the detention dam, as shown in 1981 aerial photo (Figure 10), as well as other gullies on the downstream face of the dam (Figure 7) may have resulted from 1) storm flows overtopping or breaching the crest of the dam and/or 2) headward migration of gullies on the downstream face of the dam, and/or 3) ground collapse due to piping in the earthen dam. In any case, it appears the reclamation in the mid-to-late 1980s including construction of a berm along the crest of the dam to divert storm flows from overtopping or breaching the crest of the dam (Figures 11 and 12). The storm flows were diverted northward to the spillway constructed as part of the reclamation (Figure 7).

Figure 11. Berm along crest of detention dam (view to south). Person on right stands on top of berm. Person on left stands along edge of pasture (sediment-filled reservoir) that extends about 2,000 feet upslope from the dam

Figure 12. Berm along crest of detention dam (left foreground) transitions into berm along spillway (left middle ground) (view to north)

The detention dam is adjacent to the east side of the Cripple Creek community (Figure 13). The abandoned dam has not been monitored or maintained for decades. The dam and sediment-filled reservoir have hazards and risks to public safety, infrastructure, and resources. A failure of the dam embankment could result in flooding and a debris flow/mudflow that would put lives, infrastructure, and resources at risk. The past and present use of the sediment-filled reservoir and adjoining slopes as a grazing pasture increases potential storm flow downslope to the dam.

Figure 13. Abandoned detention dam with sediment-filled reservoir next to Cripple Creek community, Wythe County, VA. Gully erosion visible on face of dam. (2001 aerial photo; view to the east)

Also in the project area the Collins Cove Group Horse Campground is located on abandoned detention dams and sediment-filled reservoirs. The campground has had erosion and sediment issues. The dams and sediment-filled reservoirs in this concentrated recreation area have hazards and risks to public safety, infrastructure, and resources.

Roads

Existing roads in the project area have altered geologic conditions that affect slope stability, surface drainage, surface erosion, groundwater, karst resources and karst landforms. Existing roads also are potential vectors for leaks or spills of petroleum products and other chemical contaminants (waste, refuse, meth and drug materials). The miles of roads in the project area are one indication of the extent of altered geologic conditions. The Forest Service has an inventory of some roads but not all roads in the project area.

1. Forest Road - A road wholly or partly within or adjacent to and serving the NFS that the Forest Service determines is necessary for the protection, administration, and utilization of the NFS and the use and development of its resources (36 CFR 212.1). Forest roads (a.k.a system roads) are roads that the Forest Service intends and are assigned maintenance level. System roads are inventoried and accounted for in the Forest transportation atlas. The project area contains about 33 miles of system roads.

2. Temporary Roads - A road or trail necessary for emergency operations or authorized by contract, permit, lease, or other written authorization that is not a Forest road or a Forest trail and that is not included in a Forest transportation atlas (36 CFR 212.1). As a result, the total miles of temporary roads constructed by the Forest Service in the project area is unknown.

   The total miles of temporary roads could be substantial because in recent decades the roads constructed on Forest Service timber sales were mainly temporary roads, not system roads.

3. Unauthorized Roads - Roads that are not System roads or temporary roads are called Unauthorized Roads in Forest Service transportation regulations (36 CFR 212). Unauthorized roads are not inventoried and accounted for in the Forest transportation atlas. Forest Service transportation program regulations (36 CFR 212.2) state specifically that unauthorized roads are not included in the forest transportation atlas. As a result, the total miles of unauthorized roads in the project area is unknown.

   The total miles of unauthorized roads could be substantial. Many of the unauthorized roads are used as unauthorized horse trails. The Forest Service has mapped about 34 miles of unauthorized horse trails in the project area.

4. Roads designated as trails - Some trails in the project area are non-system roads designated as trails.

Timber Harvest

Past timber harvest units with log landings, skid trails and skid roads have altered geologic conditions that affect slope stability, surface waters, surface erosion, groundwater, karst resources and karst landforms.

Grazing Allotments

The distinct difference between the carbonate ecosystem and the siliciclastic ecosystem is indicated by the fact that nearly all the grazing allotments acres (1,221 acres; 98%) are in the carbonate ecosystem (Figure 14).

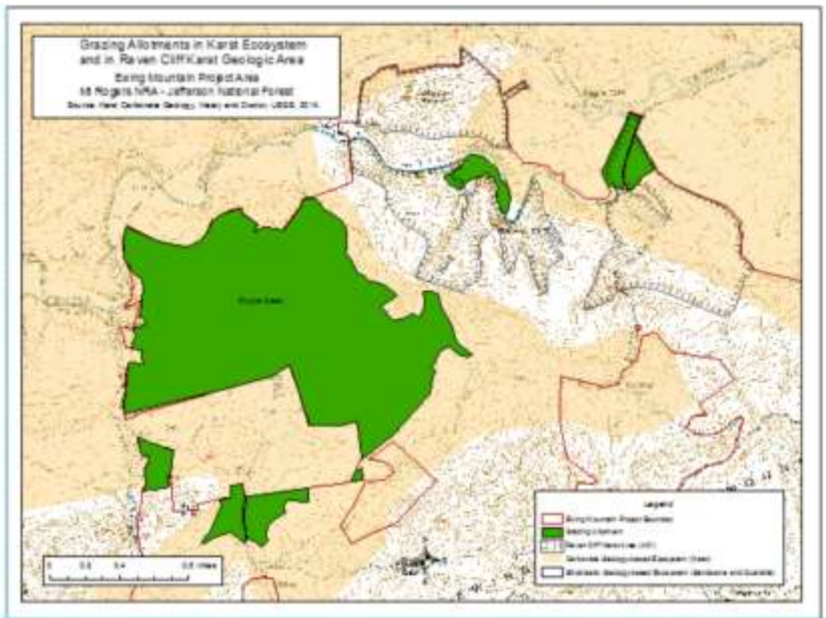

Figure 14. Grazing allotments in karst ecosystem and in Raven Cliff Karst Geologic Area (Rx 4C1)

In 1995 the federal government acquired the land now in the grazing allotments. The land has been used as grazing pasture before 1995 and after 1995. Using and maintaining the land as pasture for the grazing of livestock has several effects. First, the continuing lack of forest cover makes the pastures more susceptible to erosion and sedimentation. Unlike timber harvest areas which are reforested, grazing allotments are actively prevented from reforestation. Unlike a timber harvest unit which is restricted to 40 acres, a grazing allotment can and do exceed 40 acres. The grazing allotments in the project area perpetuate lack of forest cover on hundreds of acres of National Forest System lands.

Secondly, the grazing livestock churn up the ground surface and make the area more susceptible to erosion and Increased sedimentation. Third, the non-system roads used in the pastures are another source of erosion and sediment. Fourth, the livestock tread into the surface drainages and streams, and affect aquatic resources (Figure 15). Fifth, the livestock deposit thousands of tons of solid and liquid waste in the pastures. As a result, pollutants percolate into the ground and wash into the surface waters. The deposition of livestock wastes every year into the pastures in this karst ecosystem is an ongoing hazard for contamination of surface waters and groundwater.

Figure 15. Grazing in Cripple Creek grazing allotment located in carbonate geology-based ecosystem (karst)

The continuing ground disturbance in the grazing allotments is of special concern because part of the grazing allotment west of Cold Run contains mud wash areas with thousands of tons of fine sediment from historic mining. The Cripple Creek grazing allotment near the town of Cripple Creek contains thousands of tons of mud wash. The existing two-track road used to manage the grazing allotment in the Pellbridge area traverses this mud wash area.

Collins Cove Group Horse Camp

The Collins Cove Group Horse Campground is in midst of Raven Cliff Karst Geologic Area (Figure 16). The deposition of horse wastes every year in and around the campground in this karst ecosystem is an ongoing hazard for contamination of surface waters and groundwater. Also, the campground is located on mud wash areas containing thousands of tons of fine sediment from historic mining. The dams and sediment-filled reservoirs in this concentrated recreation area have hazards and risks to public safety, infrastructure, and resources.

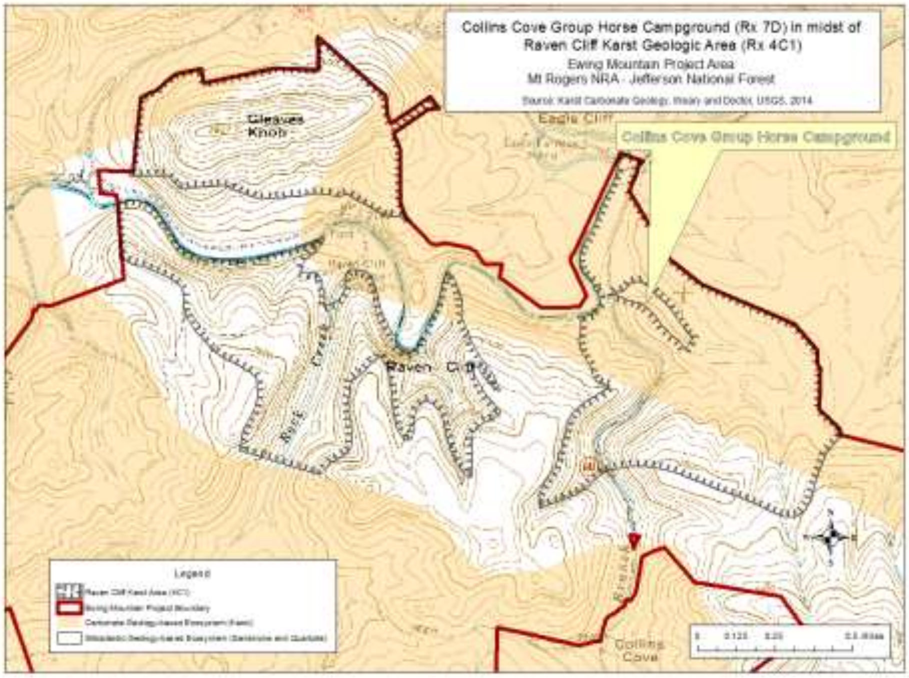

Figure 16. Collins Cove Group Horse Campground in midst of Raven Cliff Karst Geologic Area

Trails

Another continuing source of impacts in the karst carbonate ecosystem are the authorized and unauthorized horse trails. There are 5.62 miles of unauthorized horse trails in the karst carbonate ecosystem. The use of the trails leads to erosion and increased sedimentation as well as deposition of animal wastes which may impact surface water and groundwater. Some of the horse use and potential impacts occurs off the trails. For example, some horse use in the Raven Cliff karst area 4C1 Rx. is off the trail and into the bottom of a sinkhole where groundwater flows across the bottom of the sinkhole. Horse use in the sinkhole can directly contaminate groundwater.

Existing condition: groundwater and human activities

The groundwater in carbonate geology (karst) is vulnerable to impacts from human activities. Past and present activities (historic mining activity, roads, timber harvest, grazing allotments, recreation developments, and trails) may be affecting groundwater.

Existing condition: Slope stability and landslides

Landslides are part of the natural disturbance regime in the project area. Various types of landslides (such as rockslides, slumps, rockfalls, debris flows) occur sporadically in the project area, usually during rainstorms. Debris flows are a natural landslide hazard on the steep slopes within the project area. Debris flows can travel hundreds or thousands of feet downslope. A debris flow can move down through a watershed rapidly and poses a risk to public safety, resources, and infrastructure far downslope from the landslide initiation site. In the project area, the natural areas that are most susceptible to landslides, especially during storm events, are steep headwater slopes and drainages (hollows), stream banks and steep side slopes adjacent to streams.

Past human activities (mining; timber harvesting; roads, etc.) have altered geologic conditions affecting slope stability in the project area, and as a result, increased the potential for slope instability and landslides. For example, the highwall from the Little Wythe mining in the early 20th century is still unstable and producing new slope failures (landslides) (Figure 3). The highwall has at least four recent landslides (Witt, A.C., 2020).

The project area has more than 30 miles of Forest Service System (FSR) roads. The project area also has many miles of roads that are not designated as FSR roads. These non-system roads are sometimes used on timber harvest, and at that time, are called temporary roads. For example, non-system roads are proposed for use as temporary roads in the Ewing Proposed Action. The project area also has many miles of roads that are now designated as Forest Service trails.

All of these roads (FSR roads, non-system roads, and non-system roads designated as trails) have altered geologic conditions affecting slope stability in the project area, and as a result, increased the potential for slope instability and failures of constructed slopes and natural slopes. Roads require periodic maintenance to minimize potential for cut slope and fill slope failures. The FSR roads do receive periodic maintenance, but with declining budgets it is a challenge to provide road maintenance. The Forest Service does spend funds to maintain non-system roads. Without maintenance the non-system roads have increased potential for slope instability and slope failures (landslides). While

Forest Service Engineering manages the FSR roads, the Recreation Program manages the non-system roads designated as trails. Providing adequate maintenance for roads-used-as-trails can be more challenging than for FSR roads.

The project area also has log landings used in past timber harvests. Log landings use cut-and-fill construction like road construction. For any given natural slope gradient, the cut-and-fill slope cross-section for a log landing is larger than the cut-and-fill slope cross-section for a Forest Service road.

Roads and log landings in the project area have altered geologic conditions affecting slope stability, and as a result, increased the potential for slope instability and landslides (such as failures of road cut-or-fill slopes or log landing cut-or-fill slopes, or failures of natural slopes due to diversion of surface water drainage). Debris flows can also be caused by failure of fill slopes constructed for roads or log landings. Fill slopes, especially inadequately constructed and maintained fill slopes, are a potential source of debris flows in mountainous terrain (Collins 2008).

Environmental Consequences

Groundwater

The proposed action would 1) construct roads, log landings, and skid trails, 2) conduct logging operations using log skidders and other logging equipment, support vehicles including fuel supply vehicles, 3) haul timber using logging trucks. Construction equipment (bulldozers, excavators, etc.), logging equipment, and log trucks may produce leaks or spills of petroleum products in the project area at different times during timber sale operations which would occur over several years. Spills may result Accidental spills or chronic leaks may adversely affect soils, surface water and groundwater. Road dust containing road surface contaminants may drift over and settle into caves, sinkholes, karst windows exposing groundwater, and disappearing streams.

Proposed roads, timber harvest, and timber haul are potential sources of erosion and sedimentation into surface waters. In karst terrain, sediment from surface sources has the potential to infiltrate into the groundwater. The grazing allotments are all in karst terrain. The proposed roads and timber harvest in the Cripple Creek grazing allotment would be karst terrain.

The potential to impact groundwater is highest in the karst areas (carbonate geology-based ecosystem) which occur on 3,419 acres (20%) of the project area. Karst areas are vulnerable to contamination of groundwater because surface runoff into sinkholes or into disappearing streams can penetrate rapidly into the groundwater. Once contamination enters the karst groundwater system, the contamination can spread rapidly along subsurface conduits into a wider area. The closer any leak or spill is to a sinkhole the more likely it is to seep into, or be washed by surface runoff into, the sinkhole. In addition, logging contractors may see sinkholes as a convenient place to dispose of slash, other debris or waste. Herbicide application is another potential source of groundwater contamination in karst area.

A proposed timber harvest unit south of Fry Hill is karst terrain already severely impacted by past mining (Figure 17). The north end of the abandoned mine highwall extends into the harvest unit. The portion of the harvest unit west of the highwall and the proposed log landing is in highly disturbed abandoned mine land in karst terrain. The proposed timber harvest activities have the potential to result in substantial erosion and sedimentation to surface waters and the potential to adversely affect groundwater.

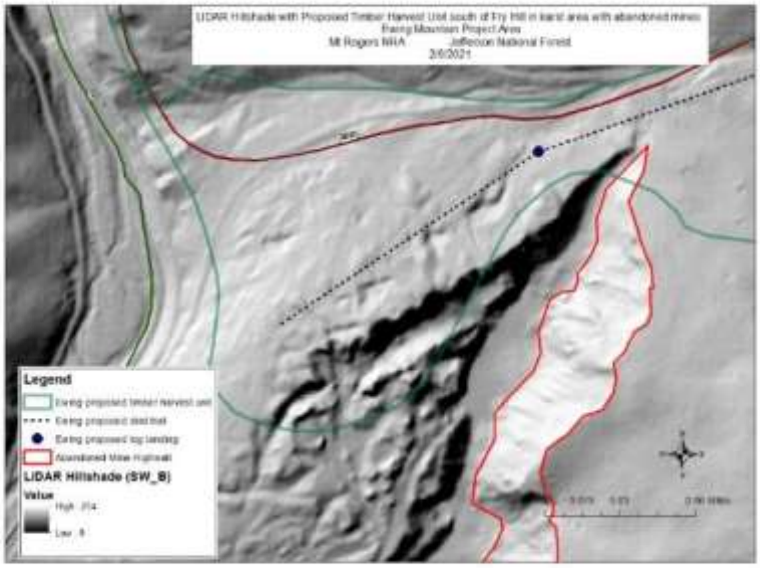

Figure 17. LIDAR Hillshade with proposed timber harvest unit south of Fry Hill in karst area with abandoned mine lands

Two standards in the Jefferson Forest Plan to address concerns in karst area:

> FW-63: A minimum of 200 foot buffers are maintained around cave entrances, sinkholes, and cave collapse areas known to open into a cave's drainage system. There are no soil-disturbing activities or harvest of trees within this buffer. Wider buffers are identified through site-specific analysis when necessary to protect caves from potential subterranean and surface impacts. Perennial, intermittent, channeled ephemeral stream standards will apply beyond the first 200 feet.
>
> FW-106: No herbicide is broadcast on rock outcrops or sinkholes. No soil-active herbicide with a half-life longer than 3 months is broadcast on slopes over 45%, erodible soils, or aquifer recharge zones. Such areas are clearly marked before treatment so applicators can easily see and avoid them.

The application of these standards as well as the other mitigation measures in the project area would reduce or avoid potential impacts to karst resources and groundwater.

Slope stability and landslides

The proposed action would conduct ground disturbing activities including constructing roads, log landings, skid trails, as well as conducting timber harvest ground-based operations. These activities would alter the geologic conditions affecting slope stability by 1) excavating cut-slopes which undercut and remove support from natural slopes, 2) placing excavated material (fill or sidecast) on natural slopes which adds weight and additional load to the natural slope, 3) concentrating and diverting surface water drainage, 4) intercepting and diverting subsurface drainage from excavated cut slopes.

Whether the alteration of geologic conditions would be sufficient to lead to slope failures depends on many factors, such as the location and design of roads, the construction inspection of roads, the mass strength properties of the bedrock and surface deposits (soils, colluvium, talus, etc.), and the duration and intensity of rainfall. One overarching factor and driver of potential impacts on slope stability is the steepness of the slopes where project activities would occur. Slope gradient (%) will be used as an indicator of potential for project activities to alter conditions affecting slope stability.

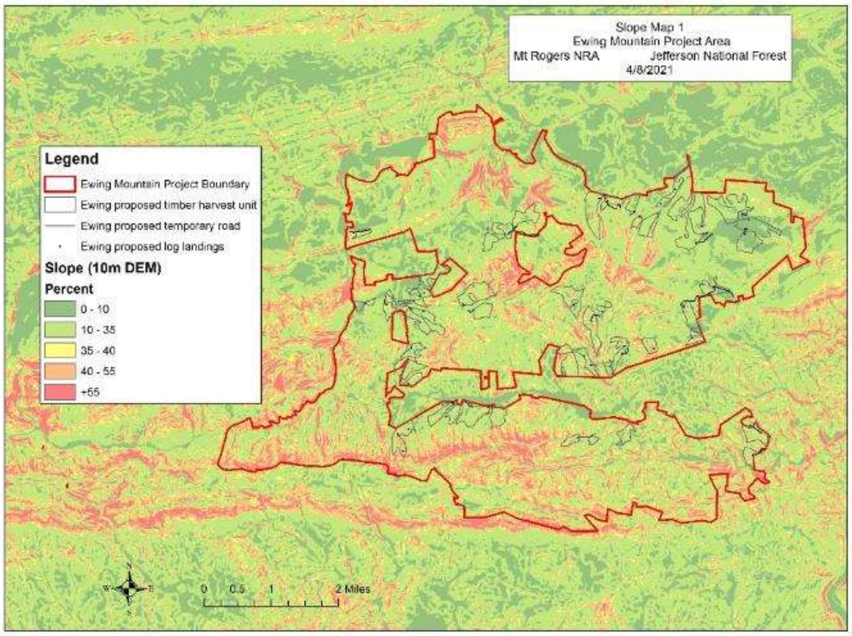

Figure 18. Slope map 1 of Ewing Mountain Project Area

Slope Map 1 shows the distribution of slopes in the project area, from gentle slopes (0-10%) to steep slopes (+55%) (Figure 18). Slope Map 1 also shows the geographic distribution of proposed roads, log landings and timber harvest units. Slope Map 2 shows the slopes less than and steeper than 35% and the geographic distribution of proposed roads, log landings and timber harvest units (Figure 19).

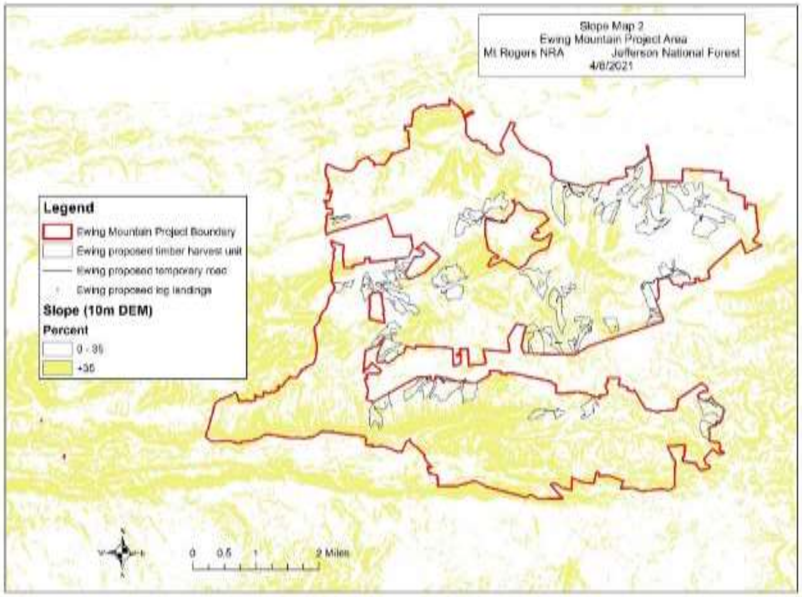

Figure 19. Slope map 2 of Ewing Mountain Project Area

Most of the proposed ground disturbing activities would be on slopes less than 35%. About 10% of the proposed ground disturbing activities would be on slopes steeper than 35%.

The Proposed Action would alter geologic conditions affecting slope stability, and thus, has a potential to create slope instability and slope failures, such as failures of road cut-or-fill slopes or log landing cut-or-fill slopes, or failures of natural slopes due to diversion of surface water drainage. Fill slopes, especially inadequately constructed and maintained fill slopes, are a potential source of debris flows in mountainous terrain (Collins 2008). Fill slopes constructed for roads and log landings on steep slopes have a potential for a fill slope failure, and possibly, a debris flow that could pose a risk to public safety, resources, and infrastructure downslope on National Forest land and non-Forest land.

Failure of constructed slopes could occur during construction or in the months or few years after construction. Sometimes it may take decades for the slope instability to develop and progress into a slope failure. Slope failures from the Proposed Action would most likely be minor and localized in effects because about 90% of the Proposed Action would be on slopes less than 35%.

On slopes greater than 35% there is increased potential for project-related slope failures. The proposed temporary road in the Collins Cove area would traverse steep slopes near the Ewing project boundary which is also the boundary with non-federal land (Figure 20).

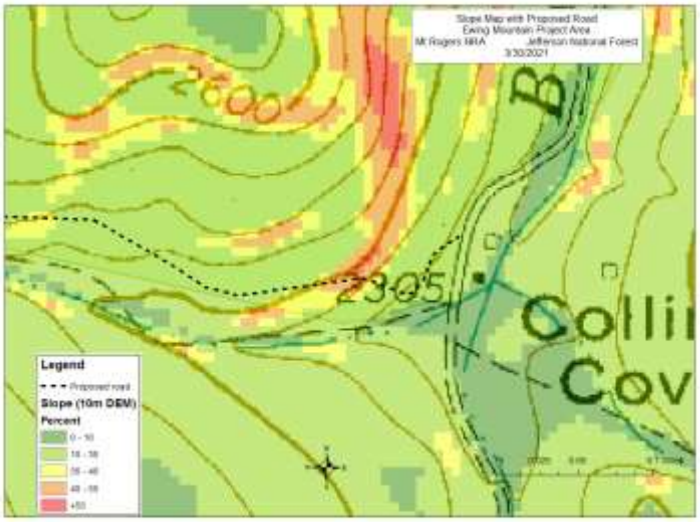

Figure 20. Slope map with proposed road for Ewing Mountain project

Due to the steep slope in this section of the proposed road in Collins Cove area there is increased potential for cut slope failure and/or fill slope failure. If a failure of the constructed slope would occur, there would be a potential to impact non-federal land downslope.

A proposed timber harvest would be located above Lick Branch Road 690. The proposed log landing and some skid trails are in an area of steep slopes, and as a result, there is increased potential for a slope failure (Figure 21). If a slope failure would occur, there would be a potential to impact non-federal land downslope.

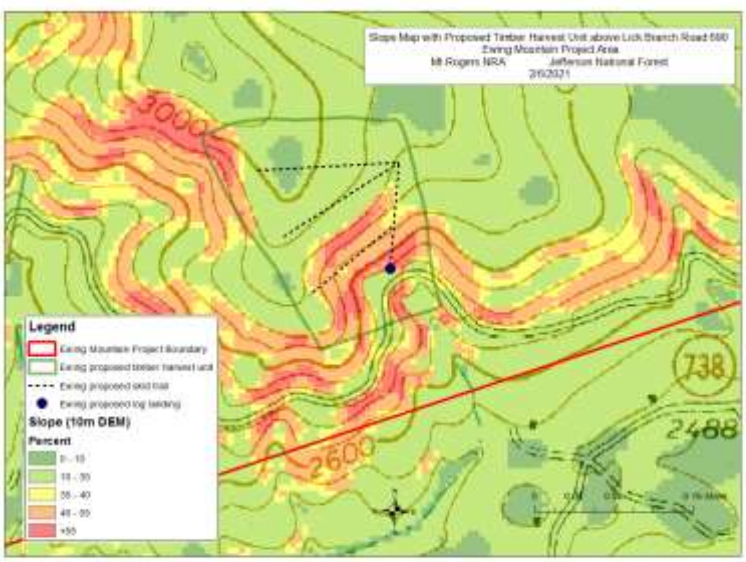

Figure 21. Slope map with proposed timber harvest unit above Lick Branch Road 690

The Proposed Action would alter geologic conditions affecting slope stability. Roads, log landings and bladed skid trails would have long term effects on conditions affecting slope stability. Timber harvest would have short term effects.

Mitigation measures, such as locating and designing most of the Proposed Action on slopes less than 35%, would reduce the potential for project-related slope failures. Mitigation measures (Design Elements and Plan standards) and the spreading out of project activities in space and time (years) would reduce the potential for project-induced slope failures. Mitigation measures would reduce, but not eliminate, the potential for project-related slope failures (landslides).

The No Action Alternative would not add to the existing alteration of conditions affecting slope stability from past activities. The potential effects from past activities would continue, including the potential for slope failures of road or log landings, and possibly, debris flows from failure of road or log landing fill slopes.

Detention Dam Hazards

A detention dam filled with sediment from historic mining operations is adjacent to the east side of the Cripple Creek community. In 1995 the federal government acquired the land with the sediment-filled reservoir and with part of the detention dam. The land was used as grazing pasture before 1995 and after 1995. The sediment reservoir used as grazing pasture is a few hundred feet wide and extends about 2,000 feet upslope from the dam (Figure 22).

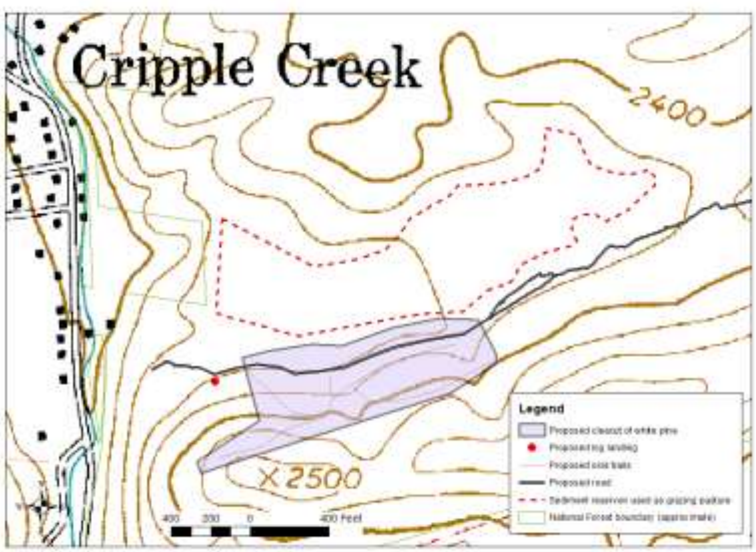

Figure 22. Topo map showing Ewing Mountain proposed action near the detention dam and sediment-filled reservoir. The detention dam occupies the steep slopes west of the sediment reservoir

With only a grass cover, the pasture is subject to surface flow runoff from storm water. During intense rainstorms the storm water flows to the berm along the dam crest. Storm flows from the grazing pasture create hazards such as a potential breach in the berm on the crest of the dam, overtopping the dam, downcutting into the dam, and failure of the dam embankment and sediment behind the dam.

The proposed action would construct a road, log landing, skid trails, and would clearcut white pines on slopes close to the detention dam and sediment-filled reservoir used as grazing pasture (Figure 22). The ground slope of the proposed 12-acre clearcut is steeper than the slope of the grazing pasture and has two ephemeral drainages and an old railroad grade. As a result, ground disturbance from logging operations, the storm runoff would be rapid and would add to the storm runoff in the pasture.

The proposed clearcut with type conversion treatment would create an additional 12 acres of Early Successional Habit (ESH) in the form of old-field and grassland habitat. The type conversion with increased storm runoff compared to the current forested slope is a long-term effect. Management actions, including possible prescribed burning every 3 or 4 years, would be used to maintain the type conversion to ESH. As a result, the proposed clearcut and type conversion not only reduces forest cover in the watershed but also would add more acres of potential rapid storm runoff to the grazing pasture that drains downslope to the dam.

The sediment-filled reservoir created a landform that is a wide floodplain sloping toward the dam (Figure 23). The pasture on the sediment-filled reservoir covers about 21 acres. The other pastureland upslope from this floodplain also produces surface flow runoff to the floodplain (Figure 24).

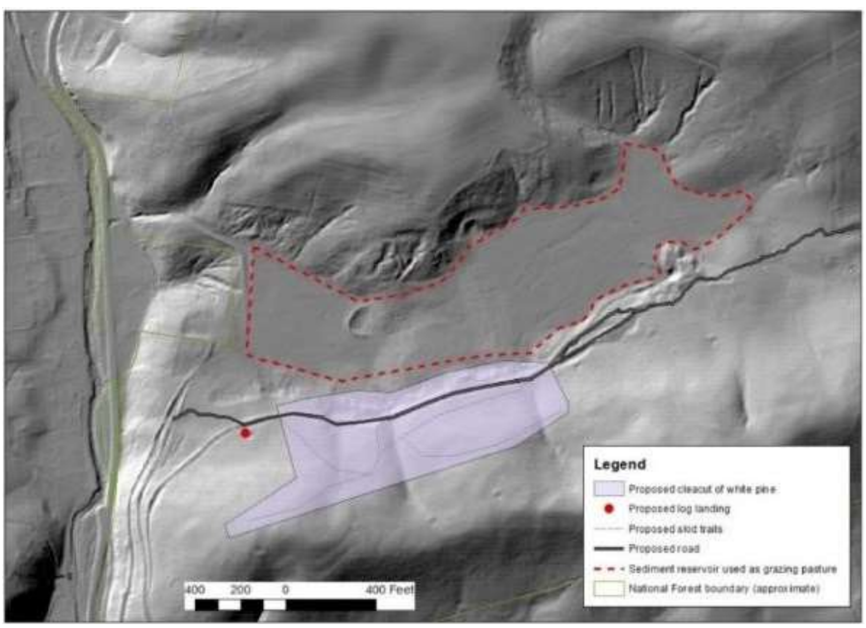

Figure 23. LIDAR hillshade image showing Ewing Mountain proposed action near the detention dam and sediment-filled reservoir. The detention dam occupies the steep slopes west of the sediment reservoir. Gullies are visible in the downstream face of the dam

The berm on the crest of the dam acts as a mini dam (Figure 11). The berm is intended to keep the flood waters from overtopping the dam. If the flood waters rise too high against the berm, the spillway is intended to divert the flood waters to another drainage (Figure 12). But the berm of earthen materials is only a few feet high, and is vulnerable to erosion by flood waters, and to breaching or overtopping.

Gullies have eroded and removed part of the dam (Figure 23). The proposed action of clearcut and type conversion would have a long-term effect of increasing potential storm flow on slopes close to the dam and sediment-filled reservoir. The proposed action would add to potential storm flow into the floodplain sloping into the dam. As a result, the proposed action would add incrementally to the existing hazards such as a potential breach in the berm on the crest of the dam, overtopping the dam, downcutting into the dam, and failure of the dam embankment and sediment behind the dam.

To assess the nature and degree of hazards in detail would require a geotechnical investigation of the dam and the sediment reservoir. The geotechnical investigation would drill into the dam 1) to determine the physical and chemical properties of materials used to construct the dam, 2) to determine the strength properties of core samples, 3) to assess groundwater conditions. The geotechnical investigation also would drill into the sediment reservoir to determine 1) the physical and chemical properties of the impounded sediments, 2) the strength properties of core samples, 3) groundwater conditions, including presence of seepage forces. The geotechnical investigation also may include geophysical methods to extend the drillhole information and to map the thickness and distribution of the sediment-filled reservoir.

The geotechnical investigation would assess other potential hazards to the dam besides storm flow. Other potential hazards to investigate and assess include:

- Potential for a landslide or slope failure of the dam embankment.
- Potential for seepage to create piping in the dam embankment and sediment reservoir.
- Potential for liquefaction and mudflow failure.
- Potential effects of groundwater base flow of the buried tributary stream on the sediment reservoir, the dam embankment, and the dam foundation.
- Potential contaminants in the sediment reservoir and dam.

The geotechnical investigation would consider all the hazards associated with a century-old dam that has not been regularly maintained. But in addition, it would need to assess the potential karst hazards to the dam. The dam and sediment reservoir are in karst geology subject to ground collapse from sinkholes. As a result, the drilling and geophysical investigations would be designed to include potential karst hazards to the dam.

The risks associated with the dam hazards are risks to public safety, infrastructure, and resources. The dam is next to the Cripple Creek community (Figure 24). A failure of the dam embankment could result in flooding and a debris flow/mudflow that would put lives and infrastructure at risk. A failure of the dam embankment and a large mass of the sediment reservoir could result in flooding and a much larger debris flow/mudflow. One result from a geotechnical assessment of the hazard could be a map of potential inundation zones which would help to assess areal extent of risks. It would also provide a basis to estimate potential sediment discharge into Francis Mill Creek and Cripple Creek due to a dam breach and debris flow/mudflow.

Figure 24. Wythe County GIS map showing Cripple Creek community near detention dam and sediment-filled reservoir used as pasture

The proposed action of clearcut and long-term type conversion (loss of forest cover) would increase potential storm flow on slopes close to the detention dam and sediment-filled reservoir/floodplain. The proposed action would have a long-term effect of adding to potential storm flow into the floodplain sloping into the dam. As a result, the proposed action would add incrementally to the existing hazards such as a potential breach in the berm on the crest of the dam, overtopping the dam, downcutting into the dam, and failure of the dam embankment and sediment behind the dam.

Based on the dam hazards and risks to public safety, infrastructure, and resources, it is recommended that the proposed action drop the proposed clearcut and other proposed ground disturbance in the watershed containing the dam and sediment-filled reservoir. It is recommended that Forest Service work in cooperation with other governmental agencies and interested and affected parties to develop and implement a plan of action, such as:

1. Rapid assessment of potential dam hazards and risks to public safety, infrastructure, and resources.
2. Begin periodic inspection and monitoring of dam.

3. Based on the results of the rapid assessment, design and conduct a geotechnical investigation to provide the information to assess hazards and risks in detail.
4. Analyze the geotechnical information and prepare a comprehensive assessment of hazards and risks, including a map of potential inundation zones in the event of a dam breach or failure.
5. Develop alternatives to abate, mitigate, and remediate the hazards. Conduct NEPA analysis of alternatives.
6. Implement decision to address hazards and risks.

Public involvement would be important throughout this process that would have several stages.

Cumulative effects

Groundwater

The Proposed Action would add incrementally to potential impacts on ground water. However, the main potential effects on groundwater are from the activities that occur every year in the karst ecosystem of the project area, and continue to accumulate effects every year, such as:

- Continued grazing and livestock waste in karst,
- Continued maintenance of hundreds of acres as grazing pasture (non-forest land) in karst,
- Continued use of authorized and unauthorized horse trails in karst,
- Continued use of Collins Cove Group Horse Campground in karst,
- Continued lack of maintenance on non-system roads in karst,
- Continued potential for mud wash areas to impact groundwater in karst.

Slope Stability and Landslides

Landslides (including debris flows) are part of the natural disturbance regime in the project area. Past human activities (mining; timber harvesting; roads, etc.) have altered conditions affecting slope stability in the project area, and as a result, increased the potential for slope instability and landslides. The proposed action would add incrementally to the potential for slope instability and landslides in excavated and constructed slopes.

Detention dams

Mining activities in the 19th century and early part of the 20th century resulted in substantial changes in landforms. Detention dams were constructed across tributary streams to collect and settle the mud and muddy water washed from the ore. A dam constructed in a tributary to Francis Mill Creek was filled with sediment from ore washing operations. The tributary stream is buried under the sediment-filled reservoir. The dam is adjacent to the Cripple Creek community.

The lack of dam maintenance over decades has cumulative effects on the condition of the dam. The dam and sediment-filled reservoir have hazards and risks to public safety, infrastructure, and resources. In addition, the sediment-filled reservoir and other areas in the watershed above the dam have been used as grazing pasture before and after the Forest Service acquired the tract in 1995. The grazing pasture increases storm runoff to the dam. In the past, storm runoff sometimes overtopped or breached the crest of the dam and contributed to gully erosion on the face of the dam. The grazing pasture affects surface and subsurface drainage. The grazing pasture and the gully erosion over decades has cumulative effects on the condition of the dam.

A harvest unit next to the pasture near the dam is proposed for type conversion from white pine plantations to a more open, non-forest state associated with old-field habitat. The clearcut and then type conversion from forest to Early Successional Habitat would have, respectively, short-term and long-term effects of increasing storm water flow. The proposed action would add incrementally to the cumulative effects of increased storm flows from grazing pasture in the watershed that drains into the dam. If the proposed action did not include the proposed clearcut and type conversion, the cumulative effects from the grazing pasture and the lack of dam maintenance would remain.

Also in the project area, the Collins Cove Group Horse Campground is located on abandoned detention dams and sediment-filled reservoirs. The dams and sediment-filled reservoirs in this concentrated recreation area have hazards and risks to public safety, infrastructure, and resources. The proposed action does not add to the cumulative effects related to the past, present and future use of a horse campground on the dams and sediment-filled reservoirs.

The abandoned mine land dams next to Cripple Creek community and at the Collins Cove Horse Campground were identified during geologic research and analysis for the Ewing Mountain timber sale project. However, the dams present issues that need to be dealt with regardless of the status of the Ewing project. As a result, recommendations have been made to address these issues regardless of the status of the Ewing project (Collins, 2021).

Long Term, Permanent, and Irreversible Effects of Temporary Roads

Some miles of temporary road would be constructed to provide access to the timber harvest areas. When the timber sale finishes with the use of a temporary road, the road is closed. Road closure typically means the road is blocked, seeded, mulched, and fertilized. These actions help to revegetate the road and reduce surface erosion. However, the road cut slopes, fill slopes, and roadbed typically remain as a source of potential short-term and long-term impacts.

Temporary roads alter geologic conditions affecting slope stability by 1) excavating cut-slopes which undercut and remove support from natural slopes, 2) placing excavated material (fill or sidecast) on natural slopes which adds weight and additional load to the natural slope, 3) concentrating and diverting surface drainage, 4) intercepting and diverting subsurface drainage, 5) excavating cut-slopes which intercept geologic structures with adverse orientation for slope stability such as dip slope bedrock bedding planes or fractures, or dip slope bedrock/colluvium contacts. The alteration of geologic conditions affecting slope stability can be sufficient to lead to slope failures, such as failures of road cut-or-fill slopes or log landing cut-or-fill slopes, or slope failures related to bladed skid trails.

The proposed temporary roads would result in permanent, irreversible alterations of geologic conditions affecting slope stability, surface drainage, subsurface drainage, and storm water runoff. Some effects would be short-term effects within a few years after road construction. Other effects would be long-term effects as natural processes (rainfall, freeze-and-thaw, gravity, etc.) operate on the cut slopes and the fill slopes. After the timber sale finishes with the use of a temporary road, and the road is closed, the road is considered a non-system road. The Forest Service does not spend funds to maintain non-system roads. Without maintenance the non-system roads have increased potential for slope instability and slope failures (landslides).

Even if a temporary road were restored to original contour, it would still result in permanent, irreversible alterations of geologic conditions affecting slope stability, surface drainage, subsurface drainage, and storm water runoff. Restoring a slope to original contour is not restoring the ground to original condition, though it may appear so and create a false impression. The temporary road excavated and remolded intact soils, colluvium, and bedrock, and then placed this mixed mass of soil and rock on the slope as fill. Restoring to original contour would require excavating and remolding the fill slope, and placing this loose, rejumbled mass of soil and rock onto the cut slope.

The permanent, irreversible alterations of geologic conditions on slopes restored to original contour include changes in mass strength properties from the original ground to the backfill restored ground; changes in the porosity, permeability, and erodibility from the original ground to the backfill restored ground; changes in the orientation and physical characteristics of the contact between the unconsolidated materials (such as colluvium) and underlying bedrock; changes in surface and subsurface drainage; in road sections where bedrock was excavated in the cut slope, the original intact bedrock (and slope support it provided) is not restored. When restoration to original contour replaces bedrock with backfill it increases the depth and quantity of unconsolidated materials overlying bedrock, and thus, reduces the mass strength of the backfill restored ground compared to the original ground.

Although the proposed action does not propose to restore temporary roads to original contour, it is discussed in order to emphasize that there is no way to avoid long term, permanent, and irreversible effects of temporary roads. These effects are permanent, irreversible alterations of geologic conditions. Whether the alterations of geologic conditions is sufficient to induce noticeable adverse effects depends on the scope and magnitude of the altered conditions. For example, a temporary use road excavated into a gentle slope may alter slope stability conditions, but not sufficiently to result in a slope failure anytime in the future. On the other hand, a temporary use road excavated into steep dip slope bedrock strata may be sufficient to result in a major rockslide in the future.

When used in the NEPA process, the term “temporary road” can create a misleading impression that a road has a temporary effect or temporary existence. It would be better to refer to a “temporary use road” rather than a “temporary road”. It would be better still to refer to a “temporary road” as a “non-system road”. There is nothing so permanent as a temporary road.

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